UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES
AND TOXIC SUBSTANCES

Note to Reader
January 8, 1998

Background: As part of its effort to involve the public in the implementation of the Food Quality Protection Act of 1996 (FQPA), which is designed to ensure that the United States continues to have the safest and most abundant food supply. EPA is undertaking an effort to open public dockets on the organophosphate pesticides. These dockets will make available to all interested parties documents that were developed as part of the U.S. Environmental Protection Agency's process for making reregistration eligibility decisions and tolerance reassessments consistent with FQPA. The dockets include preliminary health assessments and, where available, ecological risk assessments conducted by EPA, rebuttals or corrections to the risk assessments submitted by chemical registrants, and the Agency's response to the registrants' submissions.

The analyses contained in this docket are preliminary in nature and represent the information available to EPA at the time they were prepared. Additional information may have been submitted to EPA which has not yet been incorporated into these analyses, and registrants or others may be developing relevant information. It's common and appropriate that new information and analyses will be used to revise and refine the evaluations contained in these dockets to make them more comprehensive and realistic. The Agency cautions against premature conclusions based on these preliminary assessments and against any use of information contained in these documents out of their full context. Throughout this process, If unacceptable risks are identified, EPA will act to reduce or eliminate the risks.

There is a 60 day comment period in which the public and all interested parties are invited to submit comments on the information in this docket. Comments should directly relate to this organophosphate and to the information and issues available in the information docket. Once the comment period closes, EPA will review all comments and revise the risk assessments, as necessary.

These preliminary risk assessments represent an early stage in the process by which EPA is evaluating the regulatory requirements applicable to existing pesticides. Through this opportunity for notice and comment, the Agency hopes to advance the openness and scientific soundness underpinning its decisions. This process is designed to assure that America continues to enjoy the safest and most abundant food supply. Through implementation of EPA's tolerance reassessment program under the Food Quality Protection Act, the food supply will become even safer. Leading health experts recommend that all people eat a wide variety of foods, including at least five servings of fruits and vegetables a day.

Note: This sheet is provided to help the reader understand how refined and developed the pesticide file is as of the date prepared, what if any changes have occurred recently, and what new information, if any, is expected to be included in the analysis before decisions are made. **It is not meant to be a summary of all current information regarding the chemical.** Rather, the sheet provides some context to better understand the substantive material in the docket (RED chapters, registrant rebuttals, Agency responses to rebuttals, etc.) for this pesticide.

Further, in some cases, differences may be noted between the RED chapters and the Agency's comprehensive reports on the hazard identification information and safety factors for all organophosphates. In these cases, information in the comprehensive reports is the most current and will, barring the submission of more data that the Agency finds useful, be used in the risk assessments.

Jack E. Housenger, Acting Director
Special Review and Reregistration Division

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D. Water Resources Assessment

i. Summary and Conclusions

This section presents an assessment of the potential to contaminate ground water and surface water from labeled uses of disulfoton. The assessment is a Tier II estimate of environmental concentrations (EECs) in surface water for disulfoton as applied to barley, cotton, potatoes, tobacco, and spring wheat, using several label application (maximum and recommended) rates and methods, using PRZM3/EXAMS2. Surface water monitoring data collected by the USGS as part of the National Water Quality Assessment (NAWQA) (Gilliom, 1995; USGS, 1997) program is also considered. The potential for disulfoton residues in ground water is assessed using the EFED ground-water concentration screening model (SCI-GROW) and the monitoring data available in EFED's Pesticides in Ground Water Data Base (PGWDB) (USEPA, 1992) and the NAWQA study (USGS, 1997). The purpose of this analysis is to estimate environmental concentrations of disulfoton in surface water bodies and ground water for use in the human health and ecological risk assessment as part of the registration process. The environmental fate data base is not complete. Limited data indicates that the degradates are much more persistent and mobile than parent disulfoton. The degradates, often as toxic as the parent compound, are not considered in this assessment due to lack of environmental fate data.

Tier I environmental concentrations (EECs) in surface water were also estimated, using the EFED screening model GENEEC, for disulfoton as applied to barley, cotton, potatoes, tobacco, and spring wheat, using several label application (maximum and recommended) rates and methods. These estimates were greater than those estimated by PRZM/EXAMS. Surface and ground water monitoring data available in STORET were evaluated, but not considered due to limitations associated with high detection limits and difficulty in interpreting the data. The results of these findings are presented in the Appendix II.

The Tier II EEC assessment uses a single site, or multiple single sites, which represents a high-end exposure scenario from pesticide use on a particular crop or non-crop use site. The EECs for disulfoton were generated for multiple crop scenarios using PRZM3.0 (Carsel, 1997) which simulates the erosion and run-off from an agricultural field and EXAMS 2.97.5 (Burns, 1997) which simulates the fate in a surface water body. PRZM3 and EXAMS estimates for a single site, over multiple years, EECs for a 1 ha surface area, 2 m deep pond draining an adjacent 10 ha barley, cotton, potato, tobacco, or spring wheat field. Each scenario, or site, was simulated for 27 to 40 (depending on data availability) years. EFED estimated 1 in 10 year maximum peak, 4-day average, 21-day average, 60-day average, 90-day, annual average concentrations. Disulfoton (Di-Syston) formulations were based upon registered uses on the specific crops. The application rates (maximum and recommended), numbers, and intervals are listed in **Table** 2 and environmental fate inputs are listed in **Table** 4. Spray drift is determined by method of pesticide application (5% for aerial spray; 1% for ground spray, 0% for granular or soil incorporated applications). The Tier II PRZM/EXAMS EECs for disulfoton are listed in a **Table** 2. PRZM

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simulations were both made with the recommended and maximum application rates. maximum number of yearly applications, and the shortest recommended application interval.

The PRZM/EXAMS EECs are generated for high exposure agricultural scenarios and represent one in ten year EECs in a stagnant pond with no outlet that receives pesticide loading from an adjacent 100% cropped, 100% treated field. As such, the computer generated EECs represent conservative screening levels for ponds, lakes, and flowing water and should only be used for screening purposes. The EECs have been calculated so that in any given year, there is about a 10% probability that the maximum average concentration of that duration in that year will equal or exceed the EEC at the site. Tier II upper tenth percentile EECs are presented in **Table 2.**

The disulfoton scenarios **(Tables a and b)** are representative of high run-off sites for barley in the Southern Piedmont of Virginia (MLRA 136), cotton in the Southern Mississippi Valley Silty Uplands of Mississippi (MLRA 134), potatoes in the New England and Eastern New York Upland of Maine (MLRA 144A), tobacco in Southern Coastal Plain of Georgia (MLRA 133A), and spring wheat in the Rolling Till Prairie of South Dakota (MLRA 102A). The scenarios chosen are professional best judgement sites expected to produce run-off greater than would be expected at 90% of the sites where the appropriate crop is grown.

The SCI-GROW (Screening Concentration in Ground Water) screening model developed in EFED (Barrett, 1997) was used to estimate potential ground water concentrations for disulfoton parent under hydrologically vulnerable conditions. The maximum disulfoton ground water concentration predicted by the SCI-GROW using the maximum rate 9.39 lb. a.i./ac and 2 applications was 0.83 µg/L.

The fate of disulfoton in surface water and ground water and the likely concentrations cannot be modeled with a high degree of certainty, since no data are available for the aerobic and anaerobic aquatic degradation rates, and anaerobic soil metabolism. The large degree of latitude available in the disulfoton labels also allows for a wide range of possible application rates, total amounts, application methods, and intervals between applications. However, considering the relatively rapid rate of microbial degradation in the soil (<20 day aerobic soil metabolism half-life) and direct aquatic photolysis in (surface water, the disulfoton parent may degrade fairly rapidly (Howard, !991)). However, peak concentrations appear capable of being quite high, when high application rates used.

Ref.
Howard, P. H. (Ed.) 1991. Handbook of Environmental Exposure Data for Organic Chemicals. Vol. III. Lewis, Publishers. Chelsea, MI.

Limited ground water and surface water monitoring data available in the PGWDB (USEPA, 1992) and National Water-Quality Assessment (NAQWA) Program (USGS, 1997) tends to confirm fairly rapid degradation, as values measured values generally tend to be quite low. Although, no assessment can be made for degradates due to lack of data, limited data suggests that the degradates are more persistent (>200 days) than disulfoton. suggesting their presence in water for an longer period of time than the parent. The degradates also appear to be more mobile than the parent compound.

ii. Application Rates Used in Modeling

The application rates selected for use in the modeling scenarios were based upon information submitted by the registrant, analysis conducted by BEAD, and the disulfoton (Di-Syston) labels. Four factors went into selecting the application rate: 1) the range of ounces or pounds a.i.; 2) the area or length of row per acre (which is influenced by row spacing); 3) the number of applications; and 4) the application interval. The recommended and maximum rate (ounces or pounds a.i. per crop simulated) and the shortest application interval were selected. The shorter the distance between the crop rows the greater the application rate on an area basis. Two row spacing values were generally selected; one based on a near-the-maximum number of rows indicated by the label, and second based on the row spacing given in the label example (e.g., tobacco, page 8 of 14; 20 to 40 oz. per 1000 feet of row (for "any row spacing") or 13.3 to 26.7 lb. per acre or with a 48 inch row spacing). The label indicated that "any row spacing" could be as narrow as 6 inches. The narrowest row spacing used in this assessment was 12 inches. Thus a crop like tobacco had a range of application rates of 4.005 to 16.33 lb. a.i. per acre.

iii. Modeling Scenarios

Surface Water: The sites selected are currently used by EFED to represent a reasonable "at risk" soil for the region or regions being considered. The scenarios selected represent high-end exposure sites. The sites are selected so that they generate exposures larger than for most sites (about 90 percent) used for growing the selected crops. An "at risk" soil is one that has a high potential for run-off and soil erosion. Thus, these scenarios are intended to produce conservative estimates of potential disulfoton concentrations in surface water. The crop, MLRA, state, site, and soil conditions for the scenarios considered are given in **Tables a and b.**

Table a . Crop, location, soil and hydrologic group for each modeling scenario.

Crop	MLRA[1]	State	Soil Series	Soil Texture	Hydrologic Group	Period (Years)
Barley	136	VA	Gaston	sandy clay loam	C	27
Cotton	134	MS	Loring	silt loam	C	36
Potatoes	144A	ME	Paxton	sandy loam	C	36
Tobacco	133A	GA	Emporia	loamy sand	C	36
Spr.Wheat	102A	SD	Peever	clay loam	C	40

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[1]MLRA is major land resource area (USDA, 1981).

Table b. Selected soil properties used modeling.

Soil Series (MLRA)	Depth(in)	Bulk Density	Organic Carbon	Field Capacity	Wilting Point
Gaston (136)	16	1.6	1.740	0.246	0.126
	84	1.6	0.174	0.321	0.201
	50	1.6	0.116	0.222	0.122
Loring (134)	10	1.6	1.160	0.294	0.094
	10	1.6	1.160	0.294	0.094
	105	1.8	0.174	0.147	0.087
Paxton (144A)	20	1.6	2.90	0.166	0.66
	46	1.8	0.174	0.118	0.38
	34	1.8	0.116	0.085	0.035
Emporia (133A)	38	1.4	1.16	0.104	0.054
	62	1.6	0.174	0.225	0.125
	50	1.6	0.116	0.135	0.056
Peever (102A)	18	1.35	1.740	0.392	0.202
	82	1.60	0.116	0.257	0.177
	50	1.60	0.058	0.256	0.176

Ground Water: The SCI-GROW (Screening Concentration in Ground Water) screening model developed in EFED (Barrett, 1997) was used to estimate potential ground water concentrations for disulfoton parent under "generic" hydrologically vulnerable conditions. The SCI-GROW model is a model for estimating concentrations of pesticides in ground water under "worst case" conditions. SCI-GROW provides a screening concentration; an estimate of likely ground water concentrations if the pesticide is used at the maximum allowed label rate in areas with ground water exceptionally vulnerable to contamination. In most cases, a majority of the use area will have ground water that is less vulnerable to contamination than the areas used to derive the SCI-GROW estimate.

The SCI-GROW model is based on scaled ground water concentrations from ground water monitoring studies, environmental fate properties (aerobic soil half-lives and organic carbon partitioning coefficients-Koc's) and application rates.

iv. Modeling Procedure

Environmental fate parameters used in PRZM3 and EXAMS modelings are summarized in **Table** __ . The standard pond (mspond) was used. The PRZM3 simulations were run for a period of 36 years on cotton, potatoes, and tobacco, beginning on January 1, 1948 and ending on December 31, 1983. Barley was run for 27 years (1956-1983) and spring wheat was run for 40 years (1944-1983). Scenario information is summarized in **Table a and b.** The EXAMS loading (P2E-C1) files, a PRZM3 output, were pre-processed using the EXAMSBAT post-processor. EXAMS was run for the 27-40 years using Mode 3 (defines environmental and chemical pulse time steps). For each year simulated, the annual maximum peak, 96-hour, 21-day, 60-day, 90-day values, and the annual means were extracted from the EXAMS output file REPORT.XMS with the TABLE20 post-processor. The 10 year return EECs (or 10% yearly exceedance EECs) listed in **Table** 2 were calculated by linear interpolation between the third and fourth largest values by the program TABLE20. Cumulative frequency plots for each scenario are provided in Appendix II.

v. Modeling Results

a. Surface water

In the Tier II assessment, the 90th percentile of the estimated multiple year mean concentrations of disulfoton in a farm pond over multiple years simulated ranged from 3.08 µg/L for a single maximum application (@1.00 lb ai/a) to spring wheat in South Dakota to 43.24 µg/L for potatoes in Maine with the two applications at the maximum application rate (@9.39 lb ai/ac). Maximum, or peak, estimated concentrations of 117.0 µg/L occurred for two 9.39 lb. ai/ac applications of disulfoton to potatoes. For the other scenarios or recommended application rates, the maximum concentrations ranged from 7.72 to 98.19 µg/L. Because of limited data, the modeling results therefore cannot be confirmed by the monitoring data.

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Table . 2 Tier II Upper Tenth Percentile EECs for Disulfoton Used on barley, cotton, potatoes, tobacco, and spring wheat for several application (recommended and maximum) rates and management scenarios estimated using PRZM3/EXAMs.

Crop	Disulfoton Application Rate/Number/Interval/Incorp. Depth lb.ai../ac/ #/ days/ inches	Concentration (μg/L) (1-in-10 annual yearly maximum value)					
		Peak	96-Hour Avg.	21-Day Avg.	60-Day Avg.	90-Day Avg.	Annual Avg.
Barley[1]	1.00/2/21/0	17.92	17.48	15.85	13.95	12.59	7.12
Barley	0.83/2/21/0 (aerial)	18.02	17.62	16.50	14.75	13.56	7.75
Cotton[1]	1.01/3/21/2.5	16.75	16.35	14.98	13.39	12.63	7.47
Cotton	3.27/3/21/2.5	54.24	52.97	48.54	43.35	40.91	24.20
Potatoes[1]	4.01/2/14/2.5	22.08	21.62	20.21	17.78	16.13	7.98
Potatoes	9.39/2/14/0	117.00	114.50	106.50	93.54	85.92	43.24
Potatoes[1]	4.00/2/14/0	49.76	48.69	45.44	39.84	36.59	18.42
Potatoes	9.39/2/14/2.5	51.78	50.69	47.39	41.69	37.83	18.71
Tobacco	8.17/1/0/2.5	98.19	95.71	87.30	75.11	68.75	40.33
Tobacco[1]	4.00/1/0/2.5	20.85	20.27	18.24	15.70	14.38	8.17
Tobacco	16.33/1/0/2.5	85.02	82.66	74.36	64.00	58.62	33.29
Spr. Wheat[1]	1.00/1/0/0	7.90	7.72	7.08	6.03	5.51	3.08
Spr. Wheat	0.64/1/0/0 (aerial)	10.20	9.96	9.44	8.32	7.71	4.77

[1] Rate recommended on label.

The PRZM/EXAMs estimated disulfoton residue concentrations in surface water appear to be strongly related to application rate, number of applications, application interval, and method of application.

b. Ground water

The maximum disulfoton ground water concentration predicted by the SCI-GROW model (based on 2 maximum (e.g., potatoes) applications at 9.39 lb. a.i./ac) was 0.83 μg/L.

vi. Disulfoton Monitoring Data

The Pesticides in Ground Water Data Base (USEPA, 1992) summarizes the results of a number of ground water monitoring studies conducted which included disulfoton (and disulfoton degradates D. sulfone and D. sulfoxide). Monitoring, with no detections (limits of detections ranged from 0.01 to 6.0 µg/L), have occurred in the follow states (number of wells): AL (10), CA (974), GA (76), HI (5), IN (161), ME (71), MS (120), MN (754), OK (1), OR (70), and TX (188). Disulfoton residues were detected in ground water in Virginia and Wisconsin. In Virginia, 6 of the 12 wells sampled had disulfoton detections ranging from 0.04 to 2.87 µg/L. In Wisconsin, 14 of 26 wells sampled had disulfoton residues ranging from 4.0 to 100.0 µg/L. The Wisconsin study could not be located to determine the source of the high value found. One hundred twenty wells were analyzed in MS for degradates D. sulfone and D. sulfoxide and 188 wells were analyzed in TX for D. sulfone. Limits of detection were 3.80 and 1.90 µg/L for the sulfone and sulfoxide degrade, respectively, in MS. There were no degradates reported in these samples. Disulfoton residues were found in 10 (0.37%) out of 2700 surface water samples collected by the USGS in the NAWQA (USGS, 1997) and are summarized in Table **xx.** Concentrations ranged from 0.02 to 0.041 µg/L with a minimum detection limit (MDL) of 0.017µg/L. There were no detections reported in ground water in about 2200 ground-water samples.

Table 3. Summary of Detections in USGS NAQWA Study (USGS, 1997[1]).

Water Source	%> 0.01 µg/L	Maximum Concentration
Agricultural Streams	0.2	0.041
Urban Streams	0.0	0.007
Integrated Streams	0.0	0.002
Agricultural Wells	0.0	0.002
Urban Wells	0.0	None
Major Aquifers	0.0	None

[1] USGS, 1997 NAQWA, (URL http://water.wr.usgs.gov/pnsp/gwswl.html, August 1997)

REFERENCES

Gilliom, R.J., W.M. Alley, and M.E. Gurtz, 1995, Design of the National Water-Quality Assessment Program: Occurrence and Distribution of Water-Quality Conditions, U.S. Geological Survey Circular 1112, 33 p.

USGS. 1997. Pesticides in Surface and Ground Water of the United States: Preliminary

Results of the National Water Quality Assessment Program(NAWQA) August, 1997. Pesticides National Synthesis Project, National Water-Quality Assessment, U.S. Geological Survey

Several limitations for the monitoring data should be noted. These limitations include: the use of different limit of detections between studies, lack of information concerning disulfoton use around sampling sites, and lack of data concerning the hydrogeology of the study sites.

vii. Limitations of this Modeling Analysis

There are several factors which limit the accuracy and precision of this modeling analysis including the selection of the high-end exposure scenarios, the quality of the data, the ability of the model to represent the real world, and the number of years that were modeled. There are additional limitations on the use of these numbers as an estimate of drinking water exposure. Degradation/metabolism products were also not considered due to lack of data. Another major limitation in the current EXAMS simulations is that the aquatic (microbial) degradation pathway was not considered due to lack of data. Direct aquatic photolysis was however included.

Spray drift is determined by method of pesticide application: 0% percent when applied as broadcast (granular) or in-furrow, 1% for ground spray, and 5% for aerial spray.

Tier II scenarios are also ones that are likely to produce high concentrations in aquatic environments. The scenarios were intended to represent sites that actually exist and are likely to be treated with a pesticide. These sites should be extreme enough to provide a conservative estimates of the EEC, but not so extreme that the model cannot properly simulate the fate and transport processes at the site. The EECs in this analysis are accurate only to the extent that the sites represent the hypothetical high exposure sites. The most limiting aspect of the site selection is the use of the "standard pond" which has no outlet. It also should be noted that the standard pond scenario used here would be expected to generate higher EECs than most water bodies; although, some water bodies would likely have higher concentrations (e.g., a shallow water bodies near agriculture fields that receive direct run-off from the treated field).

The quality of the analysis is also directly related to the quality of the chemical and fate parameters available for disulfoton. Acceptable data are available, but rather limited. Data were not available for degradates and the aquatic aerobic metabolism rate was not known, but estimated. The measured aerobic soil metabolism data is limited, but has sufficient sample size to establish an upper 90% confidence bound on the mean of half-lives for the three aerobic soils tested in the laboratory (and submittted to EFED) and reported in the EFED One-liner Database (MRIDs 40042201, 41585101, 43800101). The use of the 90%-upper bound value may be sufficient to capture the probable estimated environmental concentration when limited data are available.

The models themselves represent a limitation on the analysis quality. These models were not specifically developed to estimate environmental exposure in drinking water so they may have limitations in their ability to estimate drinking water concentrations. Aerial spray drift reaching the pond is assumed to be 5 percent of the application rate and for ground spray it is 1 percent of the application rate. No drift was assumed for broadcast or in-furrow applications. Another limitation is the lack of field data to validate the predicted pesticide run-off.. Although, several of the algorithms (volume of run-off water, eroded sediment mass) are somewhat validated and understood, the estimates of pesticide transport by PRZM3 has not yet been fully validated Other limitations of the models are the inability to handle within site variation (spatial variability), crop growth, and the overly simple soil water balance. Another limitation is that 27 to 40 years of weather data was available for the analysis. Consequently there is a 1 in 27, 36, or 40 chance that the true 10% exceedance EECs are larger than the maximum EEC in the analysis. If the number of years of weather data were increased, it would increase the level of confidence that the estimated value for the 10% exceedance EEC was close to the true value.

EXAMS is primarily limited because it is a steady-state model and cannot accurately characterize the dynamic nature of water flow. A model with dynamic hydrology would more accurately reflect concentration changes due pond overflow and evaporation. Thus, the estimates derived from the current model simulates a pond having no-outlets, flowing water, or turnover. Another major limitation in the current EXAMs simulations is that the aquatic (microbial) degradation pathway was not considered due to lack of data. Direct aquatic photolysis was however included.

Another important limitation of the Tier II EECs for drinking water exposure estimates is the use of a single 10 hectare drainage basin with a 1 hectare pond. It is unlikely that this small system accurately represents the dynamics in a watershed large enough to support a drinking water utility. It is unlikely that an entire basin, with an adequate size to support a drinking water utility would be planted completely in a single crop or be represented by scenario being modeled. The pesticides would more likely be applied over several days to weeks rather than on a single day. This would reduce the magnitude of the conservative concentration peaks, but also make them broader, reducing the acute exposure, but perhaps increasing the chronic exposure.

Monitoring data is limited by the lack of correlation between sampling date and the use patterns of the pesticide within the study's drainage basin. Additionally, the sample locations were not associated with actual drinking water intakes for surface water nor were the monitored wells associated with known ground water drinking water sources. Also, due to many different analytical detection limits, no specified detection limits, or extremely high detection limits, a detailed interpretation of the monitoring data is not always possible.

A model with dynamic hydrology would more accurately reflect concentration changes due pond overflow and evaporation. Thus, the estimates derived from the current model simulates a pond having no-outlets, flowing water, or turnover. Another major limitation in the current EXAMs simulations is that the aquatic (microbial) degradation pathway was not considered due to lack of data. Direct aquatic photolysis was however included.

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